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10/523,636	02/04/2005	Nobuhiko Noto	SUG-183-PCT	5874

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EXAMINER	
BOOKER, VICKI B	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/523,636	NOTO ET AL.	
	Examiner	Art Unit	
	Vicki B. Booker	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 02 November 2007.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1 - 47 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1 - 47 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 04 February 2005 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to the correspondence filed November 2, 2007. Currently, Claims 1 - 47 are pending.

Information Disclosure Statement

The information disclosure statement filed February 4, 2005 fails to comply with 37 CFR 1.98(a)(3) because it does not include a concise explanation of the relevance, as it is presently understood by the individual designated in 37 CFR 1.56(c) most knowledgeable about the content of the information, of each patent listed that is not in the English language. It has been placed in the application file, but the foreign patent documents referred to therein have not been considered.

Priority

Acknowledgment is made of applicant's claim for foreign priority under 35 U.S.C. 119(a)-(d). The English translation submitted in accordance with 37 CFR 1.55 has been received and made of record. See MPEP § 201.15. Applicant can rely upon the foreign priority papers to overcome the prior art rejection of the office action dated August 7, 2007 in accordance with 37 CFR 1.55.

Double Patenting

Acknowledgement is made of receipt of a timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d). The terminal disclaimer overcomes the nonstatutory double patenting rejection of the office action dated August 7, 2007.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-11, 20-36, and 45-47 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 recites the limitation "the stack" in line 10 - 11. There is insufficient antecedent basis for this limitation in the claim.

Claim 1, lines 10-12 contains the phrase "annealing the stack so as to allow In to diffuse from the ITO transparent electrode layer into the GaAs layer to thereby convert it into a contact layer composed of In-containing GaAs", which is indefinite and renders the claim unclear. If "the stack" refers to the first conductivity type cladding layer, the active layer, and the second conductivity type cladding layer, then it is unclear how annealing the stack would allow In to diffuse from the ITO transparent electrode layer into the GaAs layer since the stack would not comprise the ITO transparent electrode layer and the GaAs layer, and there would thus be no thermal driving force to cause the In of the ITO transparent electrode layer to diffuse into the GaAs layer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 2, and **6** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh et al. (US 6,225,648 B1; dated 05/01/2001) in view of Toshihiro et al. (JP 1992-355541; published 07/08/1994; Examiner notes that a machine translation of Toshihiro et al. has been provided).

Regarding **Claim 1**, Hsieh et al. disclose a method of fabricating a light-emitting device having a light-emitting layer section configured as having a double heterostructure in which a first conductivity type cladding layer, an active layer, and a second conductivity type cladding layer, all of which being composed of $(Al_xGa_{1-x})_yIn_{1-y}P$ (where, $0 \leq x \leq 1$, $0 \leq y \leq 1$), are stacked in this order, and further comprising an ITO transparent electrode layer applying drive voltage for light-emission to the light-emitting layer section on at least either side of the first conductivity type cladding layer and the second conductivity type cladding layer (Abstract; Column 3, lines 21 – 24), comprising the steps of:

forming a GaAs layer 17 on the light-emitting layer section 14 (FIG. 2; Column 3, lines 35 - 37), and

forming the ITO transparent electrode layer 19 so as to contact with the GaAs layer 17 (FIG. 2; Column 3, lines 43 – 46).

Hsieh et al. do not teach or disclose annealing the stack so as to allow In to diffuse from the ITO transparent electrode layer into the GaAs layer to thereby convert it into a contact layer composed of In-containing GaAs. (For examination purposes, Examiner interprets "the stack" to comprise the light-emitting layer section, the GaAs layer, and the ITO transparent electrode).

Toshihiro et al. teach, in the same field of endeavor, annealing an ITO layer 24 such that the In diffuses from the ITO layer into a GaAs layer in direct contact with the ITO layer, in order to thereby form a contact layer composed of In-containing GaAs (FIG. 1; Paragraph [0007]). Toshihiro et al. teach that the annealing results in improving the ohmic contact by reducing the contact resistance between the ITO layer and the light-emitting layer section of the LED (Paragraphs [0002] - [0003]).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. by annealing the stack so as to allow In to diffuse from the ITO transparent electrode layer into the GaAs layer to thereby convert it into a contact layer composed of In-containing GaAs as taught by Toshihiro et al.

The motivation for doing so at the time of the invention would have been to reduce the high contact resistance between the ITO layer and the light-emitting layer as taught by Toshihiro et al. (See above).

Regarding **Claim 2**, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 1 as noted above, wherein the annealing is carried out at 600°C to 750°C, both ends inclusive (Toshihiro et al., Paragraph [0011]).

Regarding **Claim 6**, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 1 as noted above.

Hsieh et al. in view of Toshihiro et al. do not teach or disclose wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive.

Toshihiro et al. teach that the thickness of the cap layer in the led structure is shown schematically relative to other parts of the led structure (Paragraph [0007]).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive since it has been held that, where the general conditions of a claim are disclosed in the prior art, discovering optimum or workable ranges involves only routine skill in the art (See In re Aller, 105 USPQ 233 (C.C.P.A. 1955)).

Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh et al. (US 6,225,648 B1; dated 05/01/2001) in view of Toshihiro et al. (JP 1992-355541; published 07/08/1994) and further in view of Bass et al. ("Handbook of Optics – Volume 1, Fundamentals, Techniques, and Design", pages 12.1 – 12.39, 1995).

Regarding Claim 5, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 1 as noted above.

Hsieh et al. in view of Toshihiro et al. do not teach or disclose wherein the light-emitting layer section is configured using $(Al_xGa_{1-x})_yIn_{1-y}P$ (where, $0 \leq x \leq 1$, $0.45 \leq y \leq 0.55$).

Bass et al. teach, in the same field of endeavor, that light-emitting devices come in a broad range of material systems, and that each material system requires a different optimization (Page 12.8, Section 12.5; Page 12.15, Section 12.6).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify Hsieh et al. in view of Toshihiro et al. such that the light-emitting layer section is configured using $(Al_xGa_{1-x})_yIn_{1-y}P$ (where, $0 \leq x \leq 1$, $0.45 \leq y \leq 0.55$), since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering optimum or workable ranges involves only routine skill in the art (See In re Aller, 105 USPQ 233 (C.C.P.A. 1955)).

Claim 3, 4, 7, 8, 12, 14 – 16, 21 – 27, 39, and **42** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh et al. (US 6,225,648 B1; dated 05/01/2001) in view of Toshihiro et al. (JP 1992-355541; published 07/08/1994) and further in view of Lakhani (J. Appl Phys., volume 56, page 1888; 15 September 1984).

Regarding **Claim 3**, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 1 as noted above.

Hsieh et al. in view of Toshihiro et al. do not teach or disclose wherein the annealing is carried out so as to adjust a mean In concentration of the contact layer within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga.

Lakhani teaches, in the same field of endeavor (Abstract), that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer (Page 1888, Column 1, lines 23 - 26; Page 1890, Column 2, lines 12 – 16). Examiner notes that Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance.

At the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. such that the annealing is carried out so as to adjust a mean In concentration of the contact layer within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga, based on the teachings of Lakhani, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art. (In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 22**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 3.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani do not teach or disclose wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive.

Toshihiro et al. teach that the thickness of the cap layer in the led structure is shown schematically relative to other parts of the led structure (Paragraph [0007]).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive, since it has been held that, where the general conditions of a claim are disclosed in the prior art, discovering optimum or workable ranges involves only routine skill in the art (See In re Aller, 105 USPQ 233 (C.C.P.A. 1955)).

Regarding **Claim 24**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 3 as noted above, wherein the annealing is carried out so as to make an In concentration distribution in the thickness-wise direction of the contact layer continuously reduce as becoming more distant away from the ITO transparent electrode layer in the thickness-wise direction (See Lakhani, Page 1888, Column 1, lines 23 - 26; Page 1890, Column 2, lines 12 – 16; Examiner notes Lakhani teaches that the In concentration distribution continuously reducing as becoming more distant away from the ITO transparent electrode layer comprises the mechanism by which the contact resistance is reduced).

Regarding **Claim 26**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 24 as noted above, wherein the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side (Examiner notes that Lakhani teaches that an ohmic contact layer to GaAs, formed by annealing of an In-

containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would therefore have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani such that the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 4**, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 2 as noted above.

Hsieh et al. in view of Toshihiro et al. do not teach or disclose wherein process time of the annealing is set to 5 seconds to 120 seconds, both ends inclusive.

Lakhani teaches, in the same field of endeavor (Abstract), that an ohmic contact layer to GaAs can be formed by annealing of an In-containing layer wherein process time of the annealing is set to 5 seconds to 120 seconds, both ends inclusive (Page 1888, line 10; MPEP 2144.05 Section I.) to achieve an improved contact resistance (Page 1888, Column 1, lines 23 - 26; Page 1890, Column 2, lines 12 – 16).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. wherein process time of the annealing is set to 5 seconds to 120 seconds, both ends inclusive, based on the teachings of Lakhani, with the motivation for doing so at the time of the invention being to achieve an improved contact resistance as taught by Lakhani (See above).

Regarding **Claim 21**, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 2 as noted above.

Hsieh et al. in view of Toshihiro et al. do not teach or disclose wherein the annealing is carried out so as to adjust a mean In concentration of the contact layer within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga.

Lakhani teaches, in the same field of endeavor (Abstract), that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer (Page 1888, Column 1, lines 23 - 26; Page 1890, Column 2, lines 12 – 16). Examiner notes that Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance.

At the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. such that the annealing is carried out so as to adjust a mean In concentration of the contact layer

within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga, based on the teachings of Lakhani, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art. (In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 7**, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 1 as noted above.

Hsieh et al. in view of Toshihiro et al. do not teach or disclose wherein the annealing is carried out so as to make an In concentration distribution in the thickness-wise direction of the contact layer continuously reduce as becoming more distant away from the ITO transparent electrode layer in the thickness-wise direction.

Lakhani teaches, in the same field of endeavor (Abstract), that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer (Page 1888, Column 1, lines 23 - 26; Page 1890, Column 2, lines 12 – 16).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. such that annealing is carried out so as to make an In concentration distribution in the thickness-wise direction of the contact layer continuously reduce as becoming more distant away from the ITO transparent electrode layer in the thickness-wise direction, based on the teachings of Lakhani.

The motivation for doing so at the time of the invention would have been to improve contact resistance as taught by Lakhani (See above).

Regarding **Claim 8**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 7 as noted above, wherein the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side (Examiner notes that Lakhani teaches that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would therefore have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani such that the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 23**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 21 as noted above.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani do not teach or disclose wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive.

Toshihiro et al. teach that the thickness of the cap layer in the led structure is shown schematically relative to other parts of the led structure (Paragraph [0007]).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive since it has been held that, where the general conditions of a claim are disclosed in the prior art, discovering optimum or workable ranges involves only routine skill in the art (See In re Aller, 105 USPQ 233 (C.C.P.A. 1955)).

Regarding **Claim 25**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 21 as noted above, wherein the annealing is carried out so as to make an In concentration distribution in the thickness-wise direction of the contact layer continuously reduce as becoming more distant away from the ITO transparent electrode layer in the thickness-wise direction (See Lakhani, Page 1888, Column 1, lines 23 - 26; Page 1890, Column 2, lines 12 – 16; Examiner notes Lakhani teaches that the In concentration distribution continuously reducing as becoming more

distant away from the ITO transparent electrode layer comprises the mechanism by which the contact resistance is reduced).

Regarding **Claim 27**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 25 as noted above, wherein the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side (Examiner notes that Lakhani teaches that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would therefore have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani such that the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 12**, Hsieh et al. disclose a light-emitting device having a light-emitting layer section configured as having a double heterostructure in which a first conductivity type cladding layer, an active layer, and a second conductivity type cladding layer, all of which being composed of $(Al_xGa_{1-x})_yIn_{1-y}P$ (where, $0 \leq x \leq 1$, $0 \leq y \leq 1$), are stacked in this order; having an ITO transparent electrode layer 19 applying drive voltage for light-emission to the light-emitting layer section on at least either side of the first conductivity type cladding layer 140 and the second conductivity type cladding layer 144, so as to extract light from the light-emitting layer section 14 through the ITO transparent electrode layer 19 (FIG. 2; Column 3, lines 14 - 46).

Hsieh et al. do not teach or disclose having a contact layer composed of In-containing GaAs, formed between the light-emitting layer section and the ITO transparent electrode layer, as being in contact with the ITO transparent electrode layer, wherein the contact layer is designed to have an In concentration distribution in the thickness-wise direction thereof continuously reducing as becoming more distant away from the ITO transparent electrode layer in the thickness-wise direction.

Toshihiro et al. teach, in the same field of endeavor, annealing an ITO layer 24 such that the In diffuses from the ITO layer into a GaAs layer in direct contact with the ITO layer, in order to thereby form a contact layer composed of In-containing GaAs (FIG. 1; Paragraph [0007]). Toshihiro et al. teach that the annealing results in improving the ohmic contact by reducing the contact resistance between the ITO layer and the light-emitting layer section of the LED (Paragraphs [0002] - [0003]).

Lakhani furthermore teaches that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer (Page 1888, Column 1, lines 23 - 26; Page 1890, Column 2, lines 12 – 16). Examiner notes that Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance.

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. by having a contact layer composed of In-containing GaAs, formed between the light-emitting layer section and the ITO transparent electrode layer, as being in contact with the ITO transparent electrode layer, based on the teachings of Toshihiro et al. and Lakhani.

The motivation for doing so at the time of the invention would have been to reduce the contact resistance between the ITO layer and the light-emitting layer section of the LED as taught by Toshihiro et al. and Lakhani (See above discussion).

Furthermore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. based on the teachings of Toshihiro et al. and Lakhani such that the contact layer is designed to have an In concentration distribution in the thickness-wise direction thereof continuously reducing as becoming more distant away from the ITO transparent electrode layer in the thickness-wise direction, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art. (In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 14**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 12 as noted above.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani do not teach or disclose wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive.

Toshihiro et al. teach that the thickness of the cap layer in the led structure is shown schematically relative to other parts of the led structure (Paragraph [0007]).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive since it has been held that, where the general conditions of a claim are disclosed in the prior art, discovering optimum or workable ranges involves only routine skill in the art (See In re Aller, 105 USPQ 233 (C.C.P.A. 1955)).

Regarding **Claim 39**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 14 as noted above, wherein a mean In concentration of the contact layer is adjusted within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga (Examiner notes that Lakhani teaches, in the same field of endeavor (Abstract), that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page

1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would have therefore been obvious to one of ordinary skill in the art at the time of the invention to anneal so as to adjust a mean In concentration of the contact layer within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 42**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 39 as noted above, wherein the contact layer is designed to have C_B/C_A of 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side (Examiner notes that Lakhani teaches that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would therefore have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani such that the annealing is carried out so as to adjust C_B/C_A to 0.8 or below,

where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 15**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 12 as noted above, wherein a mean In concentration of the contact layer is adjusted within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga (Examiner notes that Lakhani teaches, in the same field of endeavor (Abstract), that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would have therefore been obvious to one of ordinary skill in the art at the time of the invention to anneal so as to adjust a mean In concentration of the contact layer within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 16**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 15 as noted above, wherein the contact layer is designed to have C_B/C_A of 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side (Examiner notes that Lakhani teaches that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would therefore have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani such that the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Claims 9, 10, 11, 18, 34, 44, 45, and **47** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh et al. (US 6,225,648 B1; dated 05/01/2001) in view of

Toshihiro et al. (JP 1992-355541; published 07/08/1994) and further in view of Saeki (US 6,483,127 B2; dated 11/19/2002).

Regarding **Claim 9**, Hsieh et al. in view of Toshihiro et al. teach or disclose Claim 1 as noted above.

Hsieh et al. in view of Toshihiro et al. do not teach or disclose further comprising a step of forming, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer.

Saeki teaches, in the same field of endeavor (Abstract), inserting an intermediate layer 22 having an intermediate band gap energy between a contact layer 23 and a multi-film light reflecting layer 17 (FIG. 6). The purpose of this intermediate layer is to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Column 7, lines 42 - 48).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. by further comprising, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer, based on the teachings of Saeki.

The motivation for doing so at the time of the invention would have been to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Saeki, Column 7, lines 42 - 48).

Regarding **Claim 10**, Hsieh et al. in view of Toshihiro et al. and further in view of Saeki teach or disclose Claim 9 as noted above, wherein the intermediate layer is formed as containing at least any one of an AlGaAs layer, a GaInP layer and an AlGaInP layer (Saeki, Column 5, lines 52 – 54).

Regarding **Claim 11** and **Claim 34**, Hsieh et al. in view of Toshihiro et al. and further in view of Saeki teach or disclose Claim 9 and Claim 10 respectively as noted above, wherein the intermediate layer 22 and the contact layer 23 are formed over the entire surface of the light-emitting layer section 14, 15, 16 in this order, and the ITO transparent electrode layer 24 is formed so as to cover the entire surface of the contact layer 23 (Saeki, FIG. 6).

Regarding **Claim 18**, Hsieh et al. disclose a light-emitting device having a light-emitting layer section 14 composed of a compound semiconductor layer, and an ITO transparent electrode layer 19 applying drive voltage for light-emission to the light-emitting layer section, so as to extract light from the light-emitting layer section 14 through the ITO transparent electrode layer 19, and having a contact layer 17, formed between the light-emitting layer section 14 and the ITO transparent electrode layer 19, as being in contact with the ITO transparent electrode layer 19, wherein the light-emitting layer section 14 is configured as having a double heterostructure in which a first conductivity type cladding layer 140, an active layer 142, and a second conductivity

type cladding layer 144 are stacked in this order; the contact layer 17 is formed between at least either one of the first conductivity type cladding layer 140 and the second conductivity type cladding layer 144, and the ITO transparent electrode layer 19 (FIG. 2; Column 3, lines 14 – 46).

Hsieh et al. do not teach or disclose a contact layer composed of In-containing GaAs; and, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer is formed.

Toshihiro et al. teach, in the same field of endeavor, annealing an ITO layer 24 such that the In diffuses from the ITO layer into a GaAs layer in direct contact with the ITO layer, in order to thereby form a contact layer composed of In-containing GaAs (FIG. 1; Paragraph [0007]). Toshihiro et al. teach that the annealing results in improving the ohmic contact by reducing the contact resistance between the ITO layer and the light-emitting layer section of the LED (Paragraphs [0002] - [0003]).

Saeki teaches, in the same field of endeavor (Abstract), inserting an intermediate layer 22 having an intermediate band gap energy between a contact layer 23 and a multi-film light reflecting layer 17 (FIG. 6). The purpose of this intermediate layer is to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Column 7, lines 42 - 48).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. by annealing the ITO layer to

form a contact layer composed of In-containing GaAs; and to form an intermediate layer between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, wherein the intermediate layer has an intermediate band gap energy between those of the contact layer and the cladding layer, based on the teachings of Toshihiro et al. and Saeki et al.

The motivation for doing so at the time of the invention would have been to reduce the contact resistance between the ITO layer and the light-emitting layer section of the LED (See teachings of Toshihiro et al. as noted above) and to use the intermediate layer to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (See teachings of Saeki as noted above).

Regarding **Claim 44**, Hsieh et al. in view of Toshihiro et al. and further in view of Saeki et al. show the light-emitting device as claimed in Claim 18 as noted above, wherein the intermediate layer is formed as containing at least any one of an AlGaAs layer, a GaInP layer and an AlGaInP layer (Saeki, Column 7, lines 49 – 53).

Regarding **Claim 47**, Hsieh et al. in view of Toshihiro et al. and further in view of Saeki et al. disclose the light-emitting device as claimed in Claim 44 as noted above, wherein the intermediate layer 22 and the contact layer 23 are formed over the entire surface of the light-emitting layer section 14, 15, 16 in this order, and the ITO transparent electrode layer 24 is formed so as to cover the entire surface of the contact layer 23 (Saeki, FIG. 6).

Regarding **Claim 45**, Hsieh et al. in view of Toshihiro et al. and further in view of Saeki et al. teach or disclose the light-emitting device as claimed in Claim 18 as noted above, wherein the intermediate layer 22 and the contact layer 23 are formed over the entire surface of the light-emitting layer section 14, 15, 16 in this order, and the ITO transparent electrode layer 24 is formed so as to cover the entire surface of the contact layer 23 (Saeki, FIG. 6).

Claim 17, 19, 20, 28, 29, 30, 31, 32, 33, 35, 36, and **46** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh et al. (US 6,225,648 B1; dated 05/01/2001) in view of Toshihiro et al. (JP 1992-355541; published 07/08/1994) further in view of Lakhani (J. Appl Phys., volume 56, page 1888; 15 September 1984) and still further in view of Saeki (US 6,483,127 B2; dated 11/19/2002).

Regarding **Claim 28**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 3 as noted above.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani do not teach or disclose further comprising a step of forming, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer.

Saeki teaches, in the same field of endeavor (Abstract), inserting an intermediate layer 22 having an intermediate band gap energy between a contact layer 23 and a multi-film light reflecting layer 17 (FIG. 6). The purpose of this intermediate layer is to

reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Column 7, lines 42 - 48).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani by further comprising, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer, based on the teachings of Saeki.

The motivation for doing so at the time of the invention would have been to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Saeki, Column 7, lines 42 - 48).

Regarding **Claim 30**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Saeki teach or disclose Claim 28 as noted above, wherein the intermediate layer is formed as containing at least any one of an AlGaAs layer, a GaInP layer and an AlGaInP layer (Saeki, Column 5, lines 52 – 54).

Regarding **Claim 32**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Saeki teach or disclose Claim 28 as noted above, wherein the intermediate layer 22 and the contact layer 23 are formed over the entire surface of the light-emitting layer section 14, 15, 16 in this order, and the ITO transparent electrode layer 24 is formed so as to cover the entire surface of the contact layer 23 (Saeki, FIG. 6).

Regarding **Claim 35**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Saeki teach or disclose Claim 30 as noted above, wherein the intermediate layer 22 and the contact layer 23 are formed over the entire surface of the light-emitting layer section 14, 15, 16 in this order, and the ITO transparent electrode layer 24 is formed so as to cover the entire surface of the contact layer 23 (Saeki, FIG. 6).

Regarding **Claim 29**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani (J. Appl Phys., volume 56, page 1888) teach or disclose Claim 21 as noted above.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani (J. Appl Phys., volume 56, page 1888) do not teach or disclose further comprising a step of forming, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer.

Saeki teaches, in the same field of endeavor (Abstract), inserting an intermediate layer 22 having an intermediate band gap energy between a contact layer 23 and a multi-film light reflecting layer 17 (FIG. 6). The purpose of this intermediate layer is to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Column 7, lines 42 - 48).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. and

further in view of Lakhani by further comprising, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer, based on the teachings of Saeki.

The motivation for doing so at the time of the invention would have been to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Saeki, Column 7, lines 42 - 48).

Regarding **Claim 31**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Saeki teach or disclose Claim 29 as noted above, wherein the intermediate layer is formed as containing at least any one of an AlGaAs layer, a GaInP layer and an AlGaInP layer (Saeki, Column 5, lines 52 – 54).

Regarding **Claim 33** and **Claim 36**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Saeki teach or disclose Claim 29 and Claim 31 respectively as noted above, wherein the intermediate layer 22 and the contact layer 23 are formed over the entire surface of the light-emitting layer section 14, 15, 16 in this order, and the ITO transparent electrode layer 24 is formed so as to cover the entire surface of the contact layer 23 (Saeki, FIG. 6).

Regarding **Claim 17**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 12 as noted above.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani do not teach or disclose further comprising, between the contact layer and either cladding layer of the

first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer.

Saeki teaches, in the same field of endeavor (Abstract), inserting an intermediate layer 22 having an intermediate band gap energy between a contact layer 23 and a multi-film light reflecting layer 17 (FIG. 6). The purpose of this intermediate layer is to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Column 7, lines 42 - 48).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani by further comprising, between the contact layer and either cladding layer of the first conductivity type cladding layer and the second conductivity type cladding layer located on the side of formation of the contact layer, an intermediate layer having an intermediate band gap energy between those of the contact layer and the cladding layer, based on the teachings of Saeki.

The motivation for doing so at the time of the invention would have been to reduce device resistance by reducing discontinuity in the valence band in order to accelerate the transport of holes (Saeki, Column 7, lines 42 - 48).

Regarding **Claim 19**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Saeki teach or disclose Claim 17 as noted above,

wherein the intermediate layer is formed as containing at least any one of an AlGaAs layer, a GaInP layer and an AlGaInP layer (Saeki, Column 5, lines 52 – 54).

Regarding **Claim 20** and **Claim 46**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Saeki teach or disclose Claim 17 and Claim 19 respectively as noted above, wherein the intermediate layer 22 and the contact layer 23 are formed over the entire surface of the light-emitting layer section 14, 15, 16 in this order, and the ITO transparent electrode layer 24 is formed so as to cover the entire surface of the contact layer 23 (Saeki, FIG. 6).

Claim 13, 37, 38, 40, 41, and **43** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh et al. (US 6,225,648 B1; dated 05/01/2001) in view of Toshihiro et al. (JP 1992-355541; published 07/08/1994), further in view of Lakhani (J. Appl Phys., volume 56, page 1888; 15 September 1984) and still further in view of Bass et al. ("Handbook of Optics – Volume 1, Fundamentals, Techniques, and Design", pages 12.1 – 12.39, 1995).

Regarding **Claim 13**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani teach or disclose Claim 12 as noted above.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani do not teach or disclose wherein the light-emitting layer section is configured using $(Al_xGa_{1-x})_yIn_{1-y}P$ (where, $0 \le x \le 1$, $0.45 \le y \le 0.55$) (Column 8, paragraph 3, lines 10-14).

Bass et al. teach, in the same field of endeavor, that light-emitting devices come in a broad range of material systems, and that each material system requires a different optimization (Page 12.8, Section 12.5; Page 12.15, Section 12.6).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani such that the light-emitting layer section is configured using $(Al_xGa_{1-x})_yIn_{1-y}P$ (where, $0 \leq x \leq 1$, $0.45 \leq y \leq 0.55$), based on the teachings of Bass et al., since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering optimum or workable ranges involves only routine skill in the art (See In re Aller, 105 USPQ 233 (C.C.P.A. 1955)).

Regarding **Claim 37**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Bass et al. teach or disclose Claim 13 as noted above.

Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Bass et al. do not teach or disclose wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive.

Toshihiro et al. teach that the thickness of the cap layer in the led structure is shown schematically relative to other parts of the led structure (Paragraph [0007]).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Bass et al. wherein thickness of the contact layer is adjusted within a range from 0.001 μm to 0.02 μm, both ends inclusive since it has been held that, where the general conditions of a claim are disclosed in the prior art, discovering optimum or workable ranges involves only routine skill in the art (See In re Aller, 105 USPQ 233 (C.C.P.A. 1955)).

Regarding **Claim 38** and **Claim 40**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Bass et al. teach or disclose Claim 13 and Claim 37 respectively as noted above, wherein a mean In concentration of the contact layer is adjusted within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga. (Examiner notes that Lakhani teaches, in the same field of endeavor (Abstract), that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would have therefore been obvious to one of ordinary skill in the art at the time of the invention to anneal so as to adjust a mean In concentration of the contact layer within a range from 0.1 to 0.6 on the basis of atomic ratio of In to the total concentration of In and Ga since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Regarding **Claim 41** and **Claim 43**, Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Bass et al. teach or disclose Claim 38 and Claim 40 respectively, wherein the contact layer is designed to have C_B/C_A of 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the

boundary position on the opposite side (Examiner notes that Lakhani teaches that an ohmic contact layer to GaAs, formed by annealing of an In-containing layer, results in an improved contact resistance because of a growth of a graded indium concentration distribution in the thickness-wise direction of the contact layer; See for example Page 1888, Column 1, lines 23 – 26 and Page 1890, Column 2, lines 12 – 16; Lakhani thereby teaches that the indium concentration is a result-effective variable that determines the contact resistance; Examiner notes that it would therefore have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Hsieh et al. in view of Toshihiro et al. and further in view of Lakhani and still further in view of Bass et al. such that the annealing is carried out so as to adjust C_B/C_A to 0.8 or below, where C_A is In concentration at the boundary position between the contact layer and the ITO transparent electrode layer, and C_B is In concentration at the boundary position on the opposite side, since it has been held that, discovering an optimum condition of a result-effective variable involves only routine skill in the art; In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)).

Response to Arguments

Applicant's arguments filed November 2, 2007 have been fully considered.

Applicant's argument on the claim rejection under 35 USC 112 of Claim 1, lines 10 – 11 with respect to the term "the stack" is not persuasive. Applicant argues that the layers that are stacked, which are the first conductivity type cladding layer, active layer, and second conductivity type cladding layer, is clearly the stack referred to in Claim 1,

line 10. Examiner notes that Claim 1, line 4 refers to how the light-emitting layer section is configured, and not to a structure termed "the stack". Examiner maintains the 35 USC 112 rejection based on the lack of antecedent basis of the term “the stack”.

Applicant's argument with regards to the 35 USC 112 rejection based on the phrase “annealing the stack so as to allow In to diffuse from the ITO transparent electrode layer into the GaAs layer to thereby convert it into a contact layer composed of In-containing GaAs” has been found persuasive. Examiner withdraws the respective rejection.

Applicant's argument with regards to the 35 USC 112 rejection based on the phrase “wherein the intermediate layer and the contact layer are formed over the entire surface of the light-emitting layer section in this order” has been found persuasive. Examiner withdraws the respective rejection.

Applicant's arguments with respect to Claims 1 – 47 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Vicki B. Booker whose telephone number is 571-270-1565. The examiner can normally be reached Monday through Thursday 9:30am to 6pm E.S.T.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone

number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

VBB
01/18/2008

/Paul Whitehead/
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